SOME FUNGOUS DISEASES OF BEETS

B. D. Halsted

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AGRICULTURAL COLLEGE EXPERIMENT STATION.

BULLETIN 107.

JANUARY 10, 1895.

Some Fungous Diseases of Beets.

BY BYRON D. HALSTED, BOTANIST.

During the past season favorable opportunities were at hand for the study of a beet root-rot, and spraying experiments for leaf fungi of beets have also been carried out; therefore the reports upon the above laboratory and field studies and experiments furnish the chief portions of the matter for the present bulletin.

The diseases of the beet, particularly of the sugar beet, have been studied and reported upon at other stations,* and one of the most interesting and practical points gained by a study of beet diseases is the determination, by Professor Bolley, of the identity of the scab of beet roots with that of potatoes. The cause of the scab of Irish, or round, potatoes has long been an open question, but thanks to the thorough study of the obscure subject by Dr. Thaxter,† Professor Bolley and others, the trouble has been ascribed to a fungus of low organization, called *Oospora scabies* Thx. The scab is quite widespread and destructive in New Jersey, and, in view of the fact that the germs of the scab disease remain active in the soil for an indefinite time, it is evident

* Prof. Pammel, Bull 15, Iowa Exper. Sta.; Prof. Bolley, Bull. 4, N. Dak. Exper-Sta.; Prof. Arthur, Bull. 39, Ind. Exper. Sta., and Prof. Bessey, Bull. 27, Neb. Exper. Sta.

† Ann. Rep. Conn. Exper. Sta., 1890, p. 91.

that potatoes and beets should not succeed each other upon soil where either is known to be badly affected with the scab. Figure 1* shows two beets that are affected with the scab.

A Root-rot of Beets.

(*Phyllosticta* Sp.)

Last April, while examining a field store-pit of beets (Mangolds) for a decay that had been complained of, a fungus was obtained that, while possibly not new to science, furnished some points during its study that are of interest. The affected roots

Fig. 1.
Scab of beets (Bolley).

did not neither become soft nor give off a disagreeable odor characteristic of a bacterial decay, or undergo the disorganization due to any of the rapidly-growing moulds; but, on the other hand, the diseased parts were quite firm, slightly shrunken, and almost coal black, this discoloration extending sometimes fully to the center of the root. In Figure 2 is shown a beet, much reduced in size, with a large diseased patch upon one side. The surface of the affected part is dotted with minute specks, which, upon

*From Bull. 4 of N. Dak. Exper. Sta., and kindly loaned by Prof. Bolley.

microscopic examination, prove to be spore-bearing flasks (pycnidia). Younger patches of the diseased roots, when placed under moist cloths and kept warm, soon develop the pycnidia in profusion and provided multitudes of oval hyaline spores, showing that it was a member of the genus Phyllosticta. For convenience, thin slices of the dark patches of the beets were employed for the development of the pycnidia, and as they were kept in a moist chamber covered with cloth, dipping down into the water in the plate holding the bell-jar, it was soon observed that the freshly-cut surface of the root after two days became covered with the pycnidia. This was repeated scores of times with the same result, namely, the profuse development upon the cut surface of the pycnidia of the Phyllosticta.

Fig. 2.
Beet showing Phyllosticta decay.

It was also noticed that occasional specks appeared upon the cloth which, when examined, proved to be pycnidia also. Instead of the sheeting, previously used, a thin cotton handkerchief of poor quality was substituted with the hope of getting the fungus to penetrate its meshes and develop the pycnidia upon the upper surface. With fresh slices of the affected beet cut smooth, the

cloth applied closely and kept moist, almost wet, there was no difficulty in getting, at the end of three days, a fine growth of the fungus upon the free surface of the handkerchief, and an abundance of pycnidia of all ages, varying from the minutest speck to those bearing multitudes of spores. Later on the pycnidia became of quite uniform size and showed the characteristic color and osteolum.

This free development of the pycnidia upon a substratum of cloth made it comparatively easy to obtain subjects for the microscope free from all foreign material whatsoever. At a time when the threads of the fungus were most abundant, scrapings from the cloth, carefully transferred to the slide, were quite sure to show the beginnings of the pycnidia, sometimes a score or more being in the field of the microscope at the same time.

Two years ago a Phyllosticta, in small quantity, was taken upon the foliage of garden beets. A comparison of this with the one found upon the roots shows that, while the pycnidia are smaller upon the leaves, the spores are practically the same in size and shape upon both leaf and root. Upon the foliage the Phyllosticta produces large circular dead spots, sometimes spreading over the greater portion of the leaf. In Figure 3 is shown a portion of a large beet leaf, natural size, that is badly spotted with the Phyllosticta.

In overhauling the beets in the storage pit it was observed that in several instances the shreds of old leaves were still adhering to the roots, and in some cases the dark patch of decay was located beneath such closely-applied leaf.

Healthy roots, obtained from a field where no Phyllosticta was to be found upon the foliage, were placed in a box and surrounded with fresh leaves obtained from a field two hundred miles away.* In ten days several diseased patches developed upon the surface of the beets, which afterwards enlarged and appeared the same as those that had been previously studied. As the leaf is more susceptible than the root, it may be a practical preventive of the rot of the latter to exercise care in removing all foliage before the roots are stored.

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*Kindly sent from beet-field near Syracuse, N. Y., by Mr. R. C. Worker.

The Beet Leaf Spot.

(*Cercospora beticola* Sacc.)

The leading fungous trouble of beets in New Jersey is the *Cercospora beticola*, Sacc., which causes a conspicuous spotting of the foliage. There seems to be no respect shown for any varieties

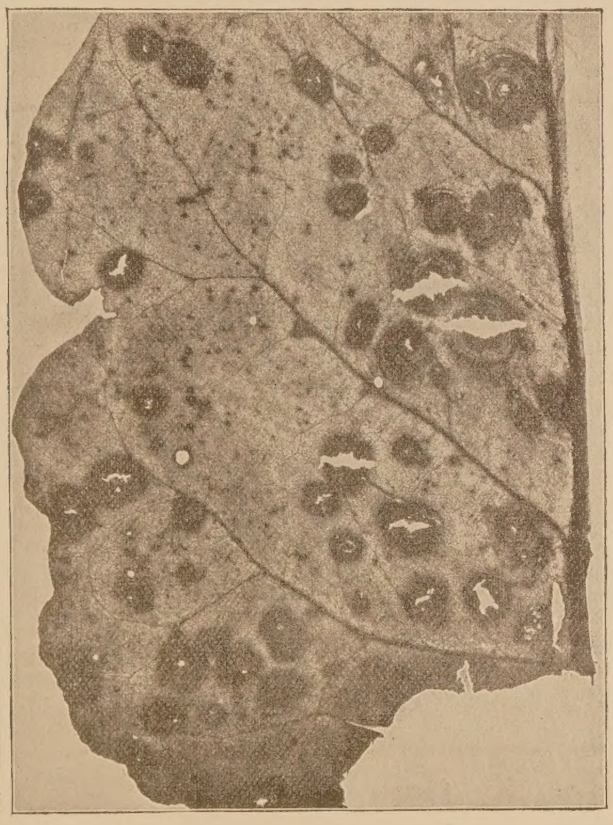

Fig. 3.
The Phyllosticta decay as affecting the beet leaves.

of beets, for the writer has made special visits to the trial grounds of large seed-growers, and all sorts of beets, from the oldest to the latest kinds, were found with their foliage equally injured.

The common name well describes the general appearance of the beet leaves infested with this Cercospora, for they are at first more or less covered with small light or ashy spots, which later often become holes by the disappearance of the tissue previously killed by the fungus. Figure 4 is an engraving made from a sun print of a beet leaf, natural size, that was badly infested with the Cercospora. Full-sized leaves often become mutilated, and sometimes scarcely more than the framework remains. The fungus itself is quite similar in structure and habits of growth to those causing leaf spots and blights in other crops. The so-called "rust" of celery is due to a Cercospora (*Cercospora Apii* Fr.), as likewise is the violet leaf spot (*Cercospora Violæ* Sacc.) These fungi consist of slender threads which run through the substance of the leaf, and, coming to the surface in groups, pass through the openings (stomata) in the skin, and in clusters bear long, slender spores in considerable numbers. These spores, when mature, fall from their points of attachment and soon germinate, thus spreading the fungus and causing other spots.

During the past season, under the special charge of Mr. J. A. Kelsey, spraying experiments have been carried out to check the Cercospora of the beet. A field of Mangolds was kindly provided by Supt. E. A. Jones, at the College Farm, and two fungicides were tested, namely, Bordeaux mixture and the ammoniacal solution of carbonate of copper. These fungicides were used in three strengths, as follows: Bordeaux mixture, full strength, with the formula; freshly-slaked lime and sulphate of copper (bluestone), each five pounds, and water twenty-five gallons; the half strength with twice as much water (fifty gallons) for the five pounds of lime and of sulphate of copper, while the quarter strength had a hundred gallons of water instead of twenty-five in the full strength. The ammoniacal copper compound was, for full strength, five ounces of the carbonate of copper dissolved in three quarts of ammonia and thirty gallons of water. The water was doubled for the half strength and again doubled for the quarter strength. In the experimental area two rows of beets were sprayed with each of these strengths, two rows being left between each set for control. In all, therefore, there were three

belts of two rows each sprayed with the Bordeaux mixture, and an equal number with the ammoniacal solution.

The sprayings began on June 21st, when the beets were six weeks old, and were continued at intervals of ten days until the tenth spraying was made, September 22d. The beet is a good test plant for strengths of fungicides, as it is comparatively tender. All of the ammoniacal solutions were too strong, and the foliage

Fig. 4.
The beet leaf spot (*Cercospora beticola* Sacc.)

was burned upon all the three belts when they were used, and therefore this fungicide was abandoned.

The use of the Bordeaux as an insecticide was interestingly shown in one instance. After an adjoining field of turnips had been harvested, an insect, previously feeding upon the turnips, invaded the beets in considerable numbers and fed upon the

untreated rows, in some instances stripping the foliage badly, but the rows sprayed with the Bordeaux were left free.

As the season progressed the Bordeaux mixture made so striking a difference in the plants that it could have been observed by anyone passing along the side of the field. The untreated rows had the foliage smaller, more upright and badly spotted with the fungus, while the sprayed plants showed a rank growth of foliage, nearly green throughout, more inclined to lop and much less spotted than the untreated plants. The difficulty of representing the differences in the foliage was appreciated. To make an engraving from a photograph of the rows in the field would not add materially to the information contained in this bulletin. It was finally decided to select two plants, one the worst in an unsprayed row and the other the poorest in a treated row adjoining; remove all the leaves, and, after drying them flat in a plant press, take a photograph of these sets of leaves with one side exposed. From the photograph thus secured Figure 5 is made. The leaves, twenty-three in number, above the tape line are from the worst sprayed plant, while the twenty-two below represent the foliage of the poorest unsprayed plant.

The best plants in each of the two rows were pulled and their foliage contrasted, as likewise the average plant in each row, with the same result, namely, the sprayed plants in all three instances gave a much larger area of leaf surface than the untreated. The contrast between the foliage of each of the two sets of plants is striking, to say the least, as shown by the accompanying engraving.

The difference between the roots in the treated and untreated rows was not so great. The two rows receiving the Bordeaux, half strength, were a fair average, and one of these rows was harvested separately and also its adjoining untreated row. The weight of roots and leaves for these two rows was as follows:

	SPRAYED.	UNSPRAYED.
Roots	416½ lbs.	331 lbs.
Leaves	63½ lbs.	49 lbs.
Total	480 lbs.	380 lbs.

This is an increase of nearly twenty-six per cent., or one-quarter, in round numbers. Therefore, the conclusion is that whatever the crop may have been per acre in this case, spraying would have increased it one-fourth, or, for example, from nine tons to twelve tons.

These experiments show that the leaf spot of the beet can be, in large measure, controlled by the use of the Bordeaux mixture. This substance is inexpensive, easily made and applied without difficulty. For field-spraying there are several kinds of horse machines, some of which apply the substance to six rows at a time. The same sprayer answers for many kinds of crops and will apply insecticides as well as fungicides, often the two being used at the same time.

Beet Rust.

(*Uromyces betæ* Pers.)

This is a genuine rust, not unlike that upon many other plants, and is mentioned here as one of the possible enemies to the beet industry in the Eastern States. It has been quite destructive in Europe, and in California the writer found it doing much damage to the beet crop in market-gardens. It is a fungus that will be quite readily recognized by the patches of rusty powder that develop in rifts of the skin of the leaf. Should it make its advent, heroic treatment would be in order. The rapidity with which the rust of the hollyhock and carnation has spread within the last five years teaches a strong lesson concerning the watch-care needed in crop-growing.

White Rust of Beets.

(*Cystopus blitii* Biv.)

Professor Pammel * reports a white mould, as found upon the sugar beet, in Iowa, and it is mentioned here as a possible enemy. It is probably the same fungus that is not uncommon upon various pigweeds (Amarantus) and the Blitum, the latter genus belonging to the beet family of plants. Weeds are frequently the harbingers of enemies to the corps, and this is an argument of no small force for their destruction.

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* Bull. 15, Iowa Exper. Sta.

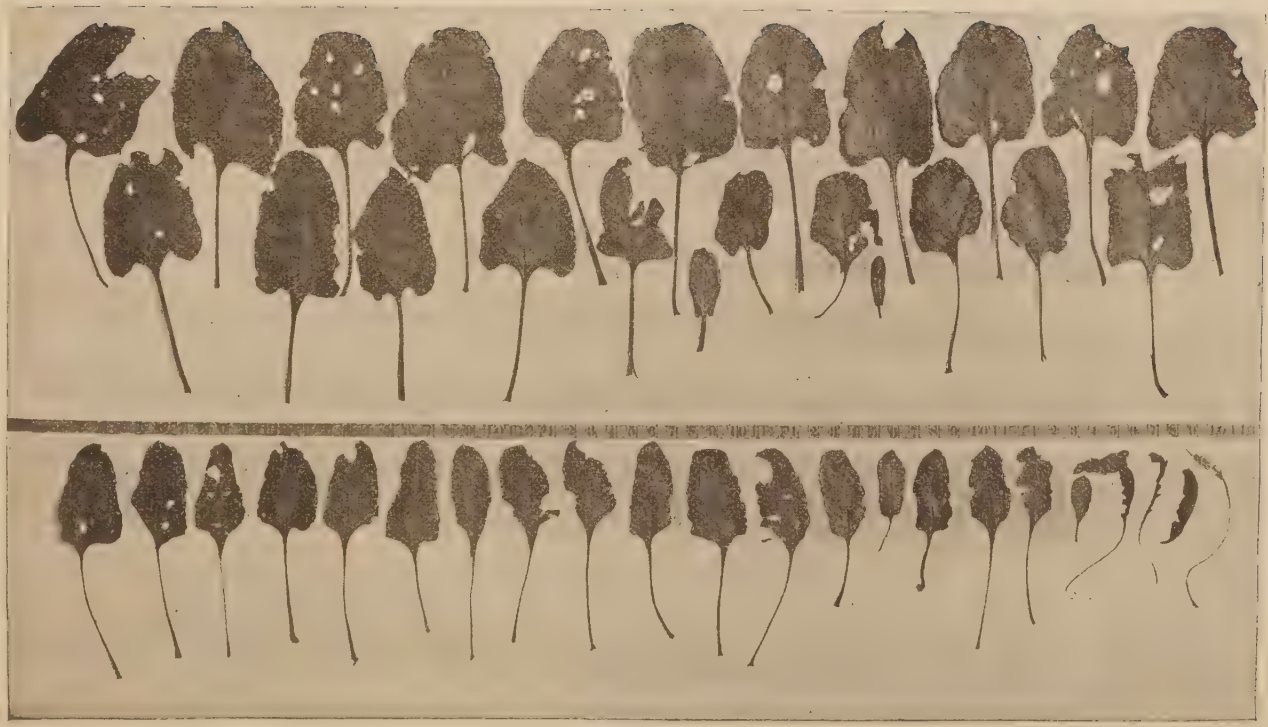

Fig. 5.
Showing foliage of poorest sprayed plant above, and worst untreated one below tape line.

The Downy Mildew of the Beet.

(*Peronospora Schæhtii* Fl.)

This species of parasitic fungus is mentioned by Saccardo* as covering the under side of the beet leaves with a downy growth. This is well shown in Kreiger's† specimens, which were collected in beet-fields in Saxony, and less so in Sydow's,‡ taken near Berlin. From the destructive habits of other mildews, similar to the one here considered, we should be thankful that the downy mildew of the beet is yet unknown to the United States.

Conclusions.

There are several fungous diseases of the beet, but only two are particularly important in New Jersey; namely, the Root-rot and Leaf Spot (*Phyllosticta* Sp.) and the Beet Leaf Blight (*Cercospora beticola* Sacc.)

The Phyllosticta causes large brown spots upon the leaves and a dark decay of the roots after they are stored. At harvest-time the foliage should all be removed from the roots, as most likely the fungus is communicated to the roots from the affected leaves by contact.

The leaf blight is the most common fungus, and field experiments with fungicides show that it can be, in large measure, controlled with Bordeaux mixture, and the crop materially increased.

It was demonstrated that the Bordeaux mixture will act as an insecticide in so far as to check beetles from feeding upon beet foliage.

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*Sylloge Fungorum, VII., p. 362.

†Fungi Saxonici, No. 396.

‡Mycotheca Marchia, No. 330.